Energy Benchmarking in Cleanroom Facilities

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Who is Doing Benchmarking

- **Web search engines find > 50,000 hits**
  - **Airline Association for Benchmarking and Measurement**
  - **Activity Based Costing Benchmarking Association**
  - **Association for Benchmarking Health Care**
  - **Aerospace & Defense Benchmarking Council**
  - **Accounting and Finance Benchmarking Consortium**
  - **Automotive Suppliers Benchmarking Association**

Benchmarking in Buildings

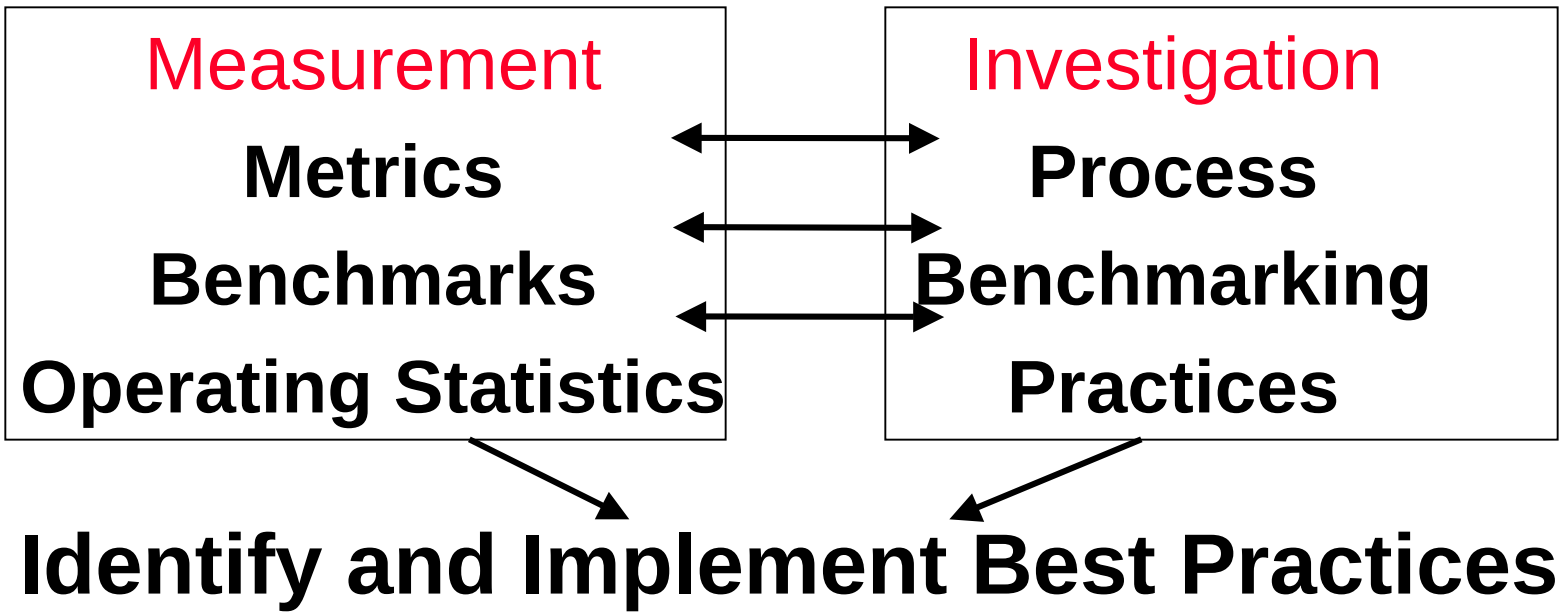
- International Facilities Management Association
- Building Owners and Managers Association
- FM Datacom/Tradeline
- US Department of Energy
- US Environmental Protection Agency

Diverse Uses of Benchmarking Term

- **Business Use**
  - …Process analysis to identify and implement best practices
- **Operations Analysis**
  - …Collection and analysis of operations data
  - …Comparisons with standard and best practice
- **Baselining**
  - …Comparing a building's energy use to itself over time
- **Performance Standards**
  - …Compare a building to others

Benchmarking for Best Practices

A business management activity that grew out of Total Quality Management



Cleanroom Energy Benchmarking

Goals of project:

- **Obtain energy use breakdown for High-tech industries**
- **Define metrics of interest**
- **Establish and begin to populate database**
- **Provide measurement data and observations to participants**

Cleanroom Energy Benchmarking

Additional goals:

- **Provide benchmark data to building owners/operators**
- **Identify best practices**

Cleanroom Benchmarking Plan

- Includes various cleanliness classes
- Large and small Utility customers included
- Focus on cleanroom environmental systems
- Data reported anonymously, but publicly
- Metrics defined

Typical Metrics

- Annual Energy Cost per cleanroom square foot — $/sf
- Annual Fuel Use — Mbtu/sf/yr
- Annual Electricity Use — kWh/sf/yr
- Power intensity — W/sf
  - —Process equipment
  - —Lighting

Important Cleanroom metrics

- **Air System efficiency** **cfm/kW**
  - **Make-up air**
  - **Recirculation air**
  - **Exhaust**
- **Chilled Water Plant efficiency** **kW/ton**
  - **Chiller Efficiency**
  - **Cooling Tower Efficiency**
  - **Chilled Water Pumps Efficiency**
- **Boiler Plant Systems** **kW/MBtu**

Typical Chiller

Other
Cleanroom metrics

- **Process Utilities**
  - **DI Plant** — **kW/gpm**
  - **Nitrogen Plant** — **cfm/kW**
  - **House Vacuum** — **cfm/kW**
  - **Compressed air** — **BHP/100acfm**

- **Lighting** — **W/sf**

Typical DI Plant

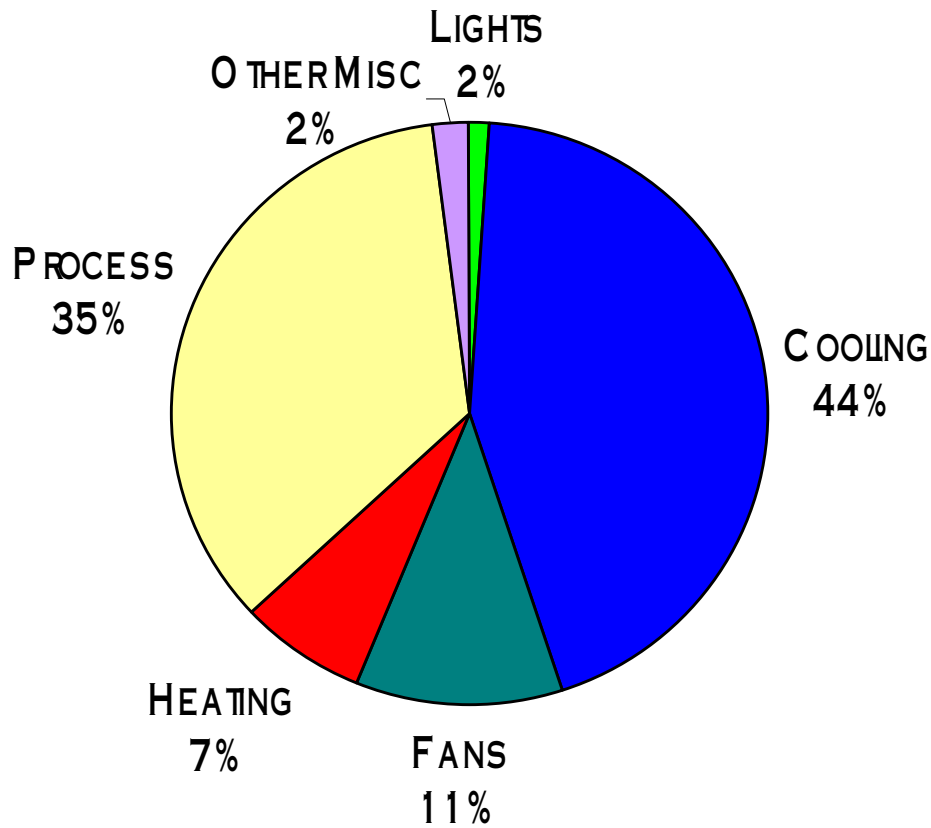
Sample Benchmark Results

Annual Energy Cost per Square Foot of Cleanroom	$43.85
Chiller Efficiency	0.50 KW/ton
Central Plant Efficiency	0.69 kW/ton
Class 10 Recirculation Units efficiency	5460 CFM/kW
Class 100 Recirculation Units efficiency	7845 CFM/kW

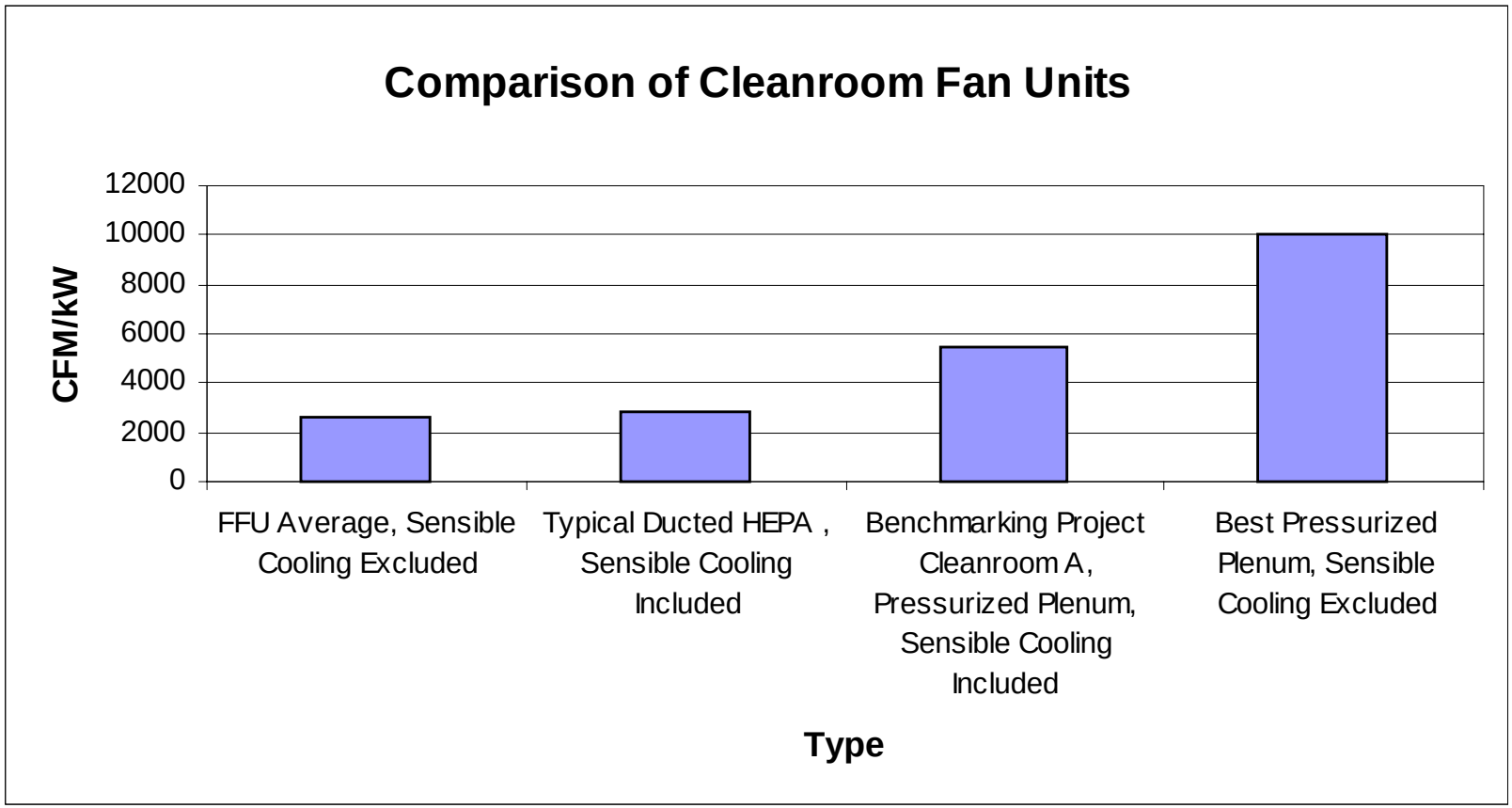
Comparison of Class 10 and 100 in one facility

	Class 10	Class 100
Primary Cleanroom Area (sf)	25,600	10,430
Total MUAH Air Flow (cfm)	17,700	9,600
Total MUAH Power (KW)	15	6.4
MUAH CFM/kW	1180	1500
MUAH CFM/sf	0.69	0.89
Total RCU Air Flow (cfm)	1,900,000	227,500
Total RCU Power (kW)	348	29
RCU CFM/kW	5460	7845
RCU CFM/sf	74	21

Representative Annual Energy Use (kWh/yr)

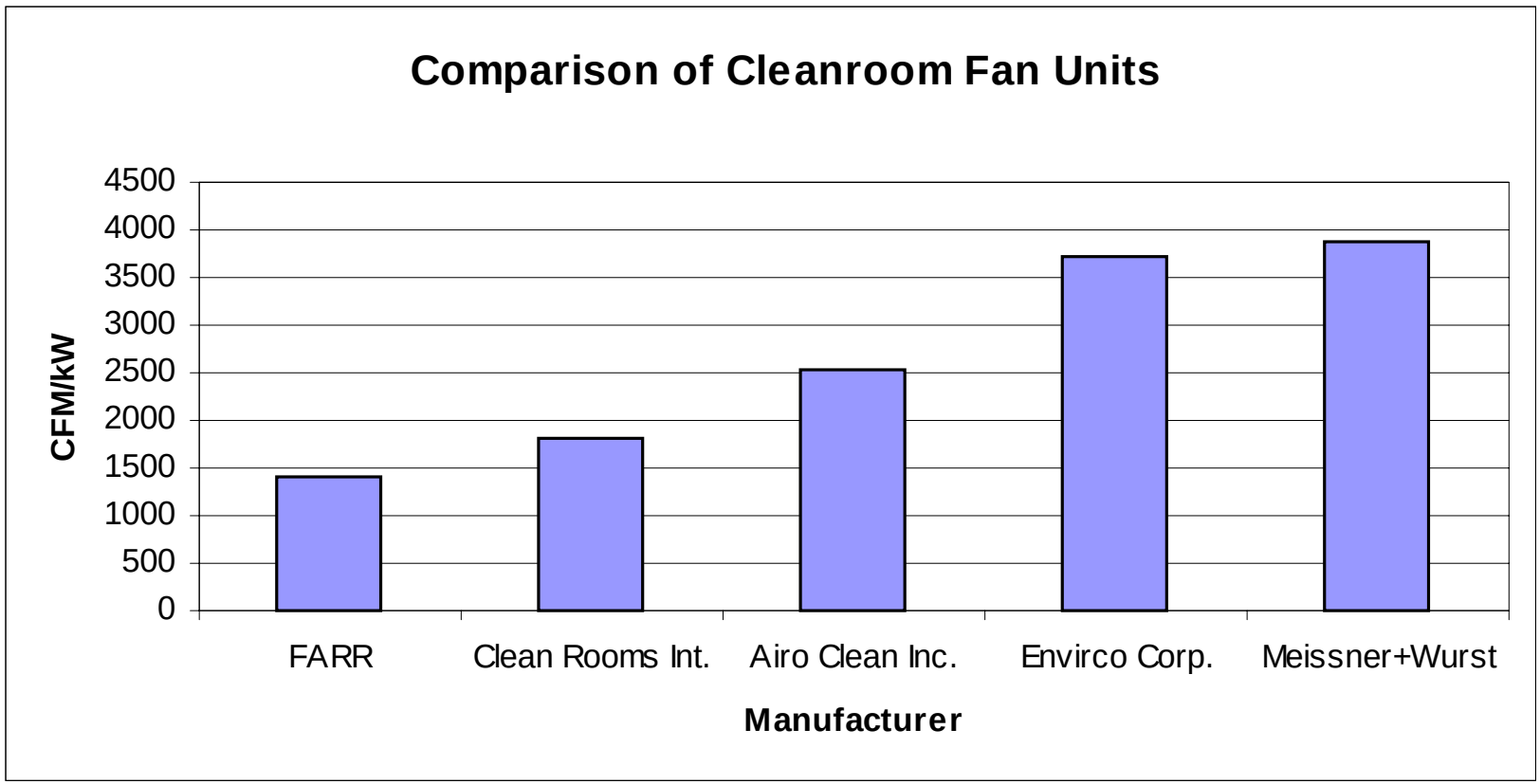


Observations from Benchmarking



Source: Supersymmetry

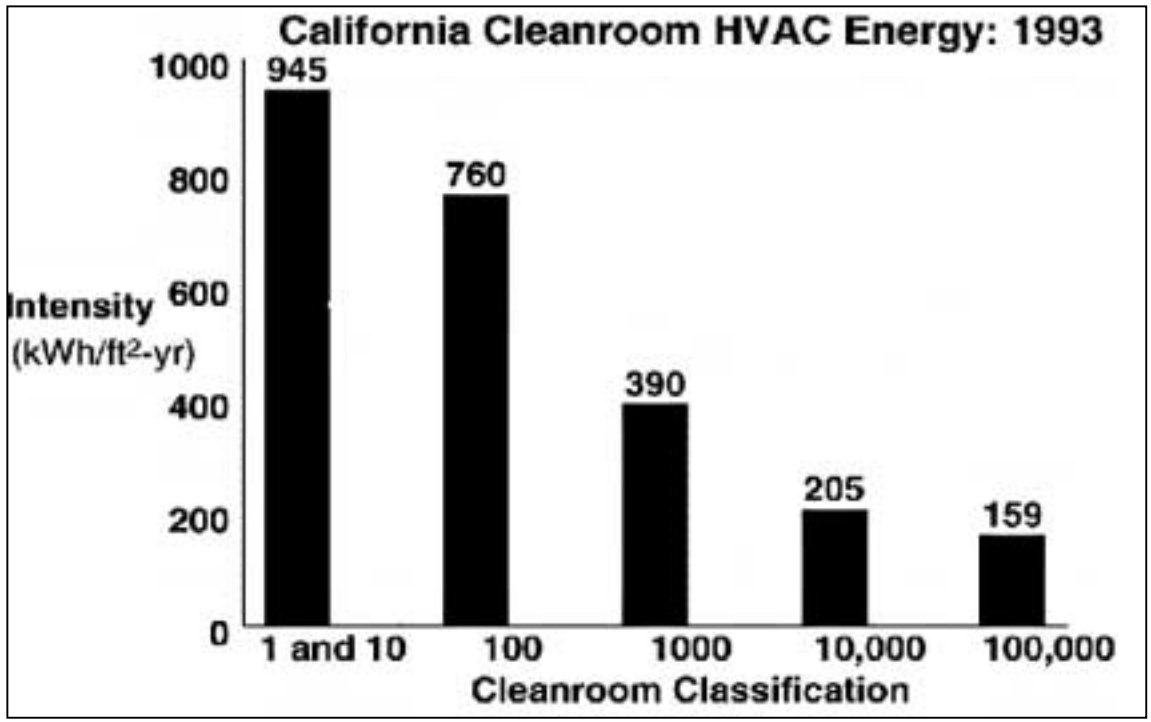
Fan Filter Units Energy Efficiency



Source: Supersymmetry

Why Cleanrooms and Lab-Type Buildings?

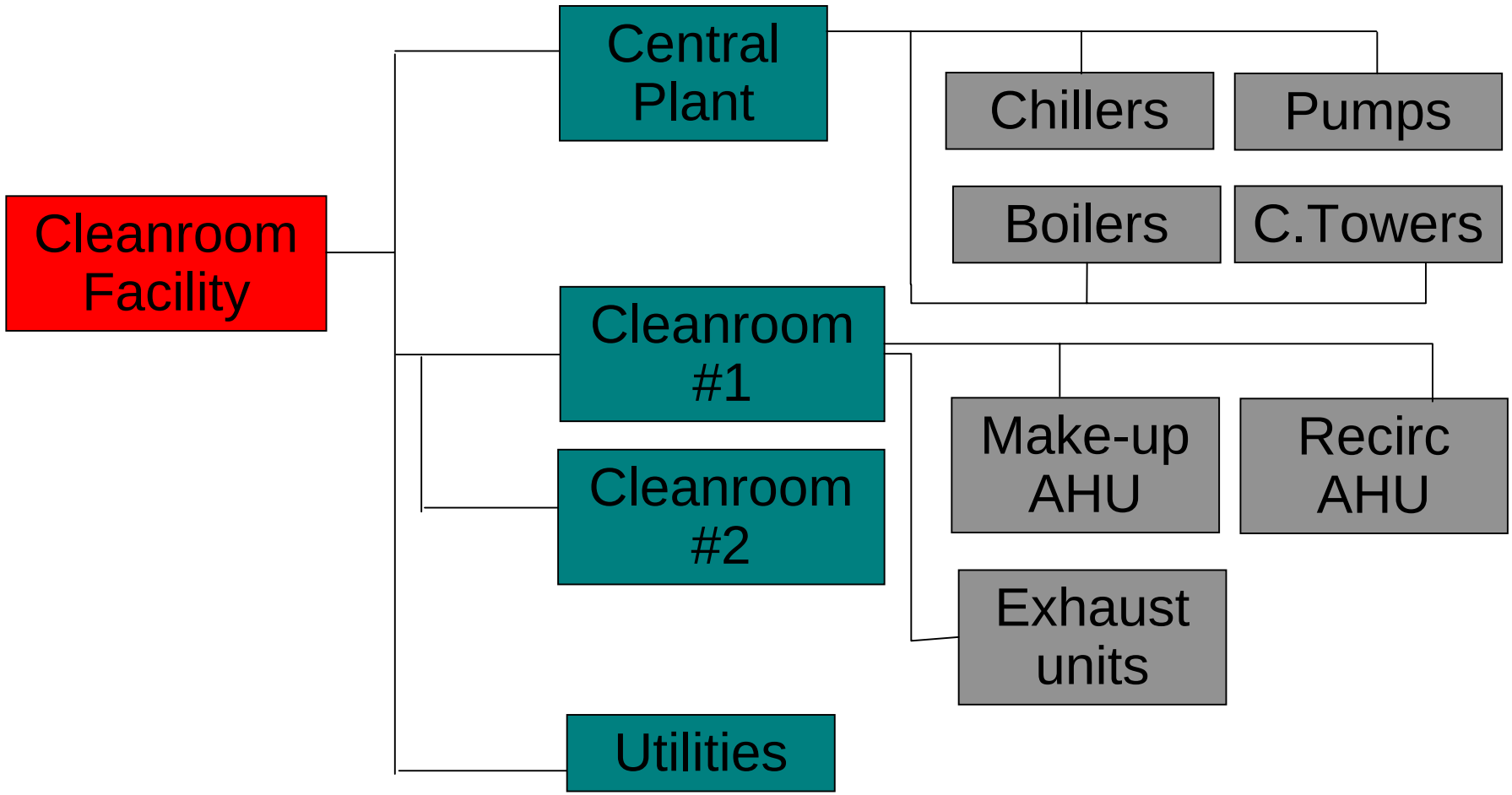
Very energy intensive

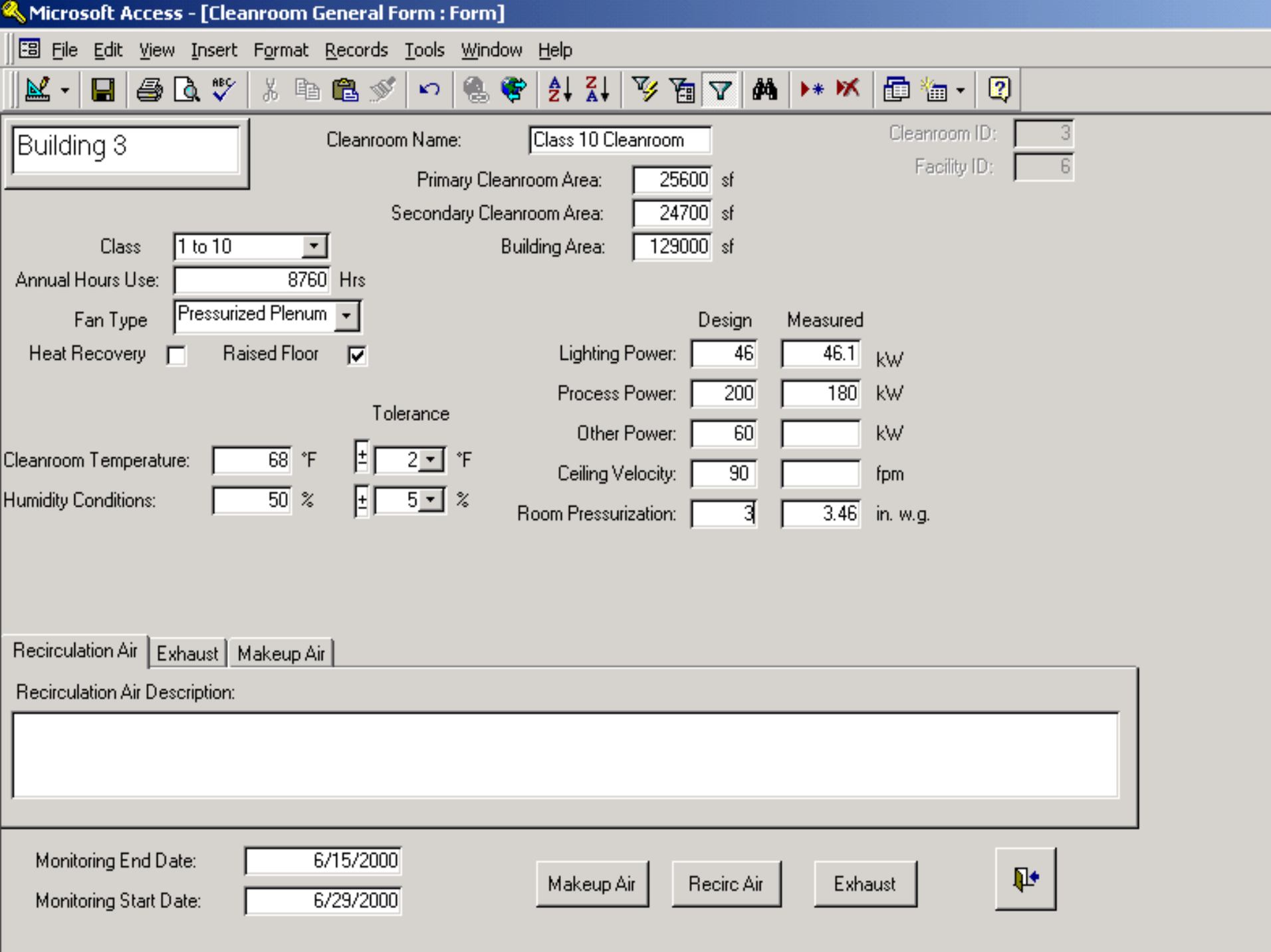


High energy-use characteristics

High airflows/exhaust rates
Strict filtration needs
Tight temperature/humidity requirements

Cleanroom Benchmarking
Database Schematic




Microsoft Access - [Cleanroom General Form : Form]
File Edit View Insert Format Records Tools Window Help
Building 3
Cleanroom Name: Class 10 Cleanroom
Cleanroom ID: 3
Facility ID: 6
Primary Cleanroom Area: 25600 sf
Secondary Cleanroom Area: 24700 sf
Building Area: 129000 sf
Class 1 to 10
Annual Hours Use: 8760 Hrs
Fan Type Pressurized Plenum
Heat Recovery
Raised Floor
Design
Measured
Lighting Power: 46 46.1 kW
Process Power: 200 180 kW
Other Power: 60 kW
Ceiling Velocity: 90 fpm
Room Pressurization: 3 3.46 in. w.g.
Tolerance
Cleanroom Temperature: 68 °F ± 2 °F
Humidity Conditions: 50 % ± 5 %
Recirculation Air
Exhaust
Makeup Air
Recirculation Air Description:
Monitoring End Date: 6/15/2000
Monitoring Start Date: 6/29/2000
Makeup Air
Recirc Air
Exhaust

Benchmark Database

- Access Data base for reporting and categorizing data
- Future ease of comparison
- Future automatic Report generation
- Web access for easy comparison
- Possible use for self entry and evaluation

How Do you compare

?

A-Team Activities
Philosophy
The Team
Career Opportunities
Contact the Ateam

Methods of conserving energy through new designs for implementation in high tech industries are detailed in this guide. Energy efficient devices featured such as fume hoods and cleanrooms offer operational efficiency in laboratories.

A Design Guide for Energy-Efficiency Research Laboratories

Other helpful links:
Labs for the 21st Century
Cleanrooms by LBNL
Fume Hood - Student Web Sites
High Tech Building Research and Development

Cleanrooms Website

http://eetd.lbl.gov/cleanrooms/